SASKATCHEWAN RESEARCH COUNCIL

ASSESSMENT OF THE POTENTIAL OF GROWING UNCONVENTIONAL ENERGY CROPS OR MULTI-USE CROPS ON SALINE OR MARGINAL LAND

PHASE I

Year 3 Report
on
Crop Yields and Composition

by

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We also acknowledge Professor R.J. Baker of the Crop Science Department, University of Saskatchewan who provided us with a statistics package for the IBM-PC microcomputer.

SUMMARY

1. (a) Perennial grasses at anthesis, grown on dry land at Saskatoon, Saskatchewan in 1983.

Twelve slender wheat grass (SWG) genotypes were grown with Revenue (SWG), Orbit (tall wheat grass), Summit (crested wheat grass) and Altai (wild rye grass). Altai had the highest crude protein (CP) content and the highest organic matter digestibility (OMD). All the SWG genotypes were lower than Revenue in CP content and all but 1717 and 1269 were less than Revenue in OMD. Revenue had the lowest cellulose content of all the grasses and only SWG genotypes 1320 and 1711 were lower in hemicellulose content.

SWG genotype 1269 was the highest of all SWG's in DM, CP and total digestible nutrient (TDN) production. Altai had by far the highest DM, CP and TDN production of all these grasses under these dry land, non-saline conditions.

(b) Perennial grasses at anthesis, grown on a saline gradient near Langham, Saskatchewan in 1983.

The same grasses studied in 1(a) were grown in a six replicate, randomized complete block running up a slope from the edge of a slough. The trial was not truly replicated since it was compounded by a reduction in salinity and moisture as the replicates were placed higher up the slope and was variable in salinity within replicates. In this trial only Altai was significantly higher than Revenue in both CP content and OMD. All the SWG's except 1711 were lower than Revenue in CP content and OMD. Altai and SWG genotypes 1650, 1307 and 1320 are all significantly higher than Revenue in cellulose content. All the SWG genotypes except 1269 and

1650 are higher than Revenue in hemicellulose content, although only genotypes 1320, 1346 and 1587 are significantly higher. Only SWG genotype 1269 is significantly higher than Revenue in DM and TDN production.

(c) Perennial grass residues at maturity, grown on a saline gradient near Langham, Saskatchewan in 1983.

At this stage of maturity Altai has the highest CP, ash, P and OMD content of all the grasses. This indicates that the forage quality of Altai does not deteriorate as rapidly as it does for the other perennial grasses, as maturity proceeds. All the SWG genotypes are lower than Revenue in CP content and only genotypes 1717, 1194, 1320 and 1358 are noticeably higher than Revenue in OMD. Only Altai and Summit are significantly different (higher) than Revenue in OMD. SWG genotypes 1650, 1587, 1307 and 1269 produce more DM, CP and TDN than Revenue, but not significantly more.

On the basis of OMD and CP content and DM, CP and TDN production, SWG genotype 1269 appears to be consistently among the best of the SWG's in these trials.

2. Jerusalem artichoke

Jerusalem artichoke were grown under dryland conditions, on sandy soil, at Saskatoon, Saskatchewan in 1983. The CP content of both tops and tubers were lower than those grown under irrigation in 1982 (Kernan, et al. 1983) while their OMD's were about the same. Although the DM, CP and TDN production was less than half that produced under irrigation in 1982, they were considerably higher than that produced by the perennial grasses.

The whole plant production of DM, CP and TDN was considerably higher

at full flowering than at maturity but not significantly so. A single pass harvesting system for Jerusalem artichoke tops and tubers would be necessary, an efficient and economically feasible pretreatment of the tops prior to enzyme hydrolysis would need to be devised, and an efficient and economically feasible protein extraction method developed before it would be practical to harvest both tops and tubers of this crop.

3. Fodder Beets

Five cultivars of fodder beets were grown under irrigation at Outlook, Saskatchewan in 1983. The DM yield of Peromona tubers was 30.6 tonnes/ha. The soluble sugar content of Peromona was 15.0% on a fresh weight basis. Peromona tubers will yield 23.1 tonnes of sucrose equivalent per hectare. which is almost double the sucrose produced by sugar beets in Canada. This could be a productive energy crop for the Outlook area and is worth investigating further.

INTRODUCTION

The general outline of, and reasons for, field experiments has been described in the Year I Report (Coxworth et al., 1982). Field plots were established at several locations (Swift Current, Saskatoon and Langham).

1. Swift Current

The saline seep site used during the first two years of this project was not available for Year III. Permission was received from Mr. Vic Remple to use a saline gradient on his farm near Swift Current. Salinity measurements were made by J.L. Henry of the Saskatchewan Institute of Pedology, University of Saskatchewan, which confirmed that this site was a true saline gradient.

Several perennial grasses, sweet clover and several annuals were planted in the spring of 1983. We decided, with the agreement of the Scientific Authority, that since serious weed infestation was encountered in this establishment year, since growth was not particularly good, and since new field experiments were started which would be continued the following year, this section of the work would be reported in Phase V of the project.

2. Langham

(i) Perennial grasses and annuals on a new saline gradient.

Permission was obtained from Mr. Alan Brown to develop another saline gradient near the site used for the comparison of the slender wheat grass (SWG) genotypes, on his farm south of Langham. A field trial similar to the one at Swift Current was initiated with roughly the

same results. We decided to report these results in Phase V of this project as well.

(ii) Perennial grasses on the old saline gradient.

The comparison of the 12 SWG genotypes with other perennial grasses was continued. The plots were harvested at anthesis and maturity. Soil sampling for salinity analysis was not repeated in 1983.

3. Saskatoon

(i) Conventional non-saline soil at Saskatoon. Saline tolerant crop evaluation of perennial grasses.

This is a repeat of the trial conducted in Year II with the same perennial grasses compared at Langham. A severe hail and rain storm seriously affected most of the field trials conducted on this site. The perennial grasses recovered reasonably well but were only harvested at the anthesis stage of maturity.

(ii) Conventional non-saline soil at Saskatoon. Non-conventional crop evaluation.

We initiated this trial to confirm the results obtained in Year II of this project. Four replicates each of Cascade oats, Lathyrus tingitanus (Tunisian flat pea), millet and quinua (Puno-15) were planted early in the spring. An excellent initial growth of these crops was devastated by a severe hail storm followed by flooding on June 24, 1983. Although all crops recovered to some extent, they were not considered worth harvesting.

(iii) Jerusalem artichokes. Dry land trial.

The trial was conducted to confirm the results obtained in Year II and to compare total biomass production at flowering and maturity. We

were unable to confirm the results from Year II since this trial was not irrigated.

(iv) Fodder beets. Irrigated trial at Outlook, Saskatchewan.

Agronomic data and samples were obtained from a trial conducted by D.A. Scott of Danosco Enterprises.

MATERIALS AND METHODS

The growth trials were conducted at Saskatoon and at Langham.

Perennial Grasses

Two growth trials were conducted to compare 12 slender wheat grass genotypes with Revenue (SWG), Orbit (tall wheat grass (TWG)), Summit (crested wheat grass (CWG)), and Altai (wild rye grass (WRG)).

1. Dry land trial at Saskatoon (established in 1981)

This trial consisted of four replicates of randomized plots, 1.2 m (4 ft.)[1] wide and 6.1 m (20 ft.) long. Each plot contained four rows, 0.3 m (one foot) apart[2]. Two 5.5 m (18 foot) rows were harvested from each plot at anthesis. The choice of rows were determined by computer selection on a random basis. The total plant material from each plot was weighed and a randomly selected, 500 g sample was taken for moisture determination and weighed accurately in the field. The 500 g sample for moisture determination and about 1000 g of the remaining plant material from each plot were placed in paper bags and transported to the laboratory where they were air dried to a relatively low moisture content. The 500 g sample was dried further in an oven at 110°C for 4 hours to determine the dry matter yield. All results, including tuber yields, are reported on a dry matter basis unless stipulated otherwise.

The air dried samples were chopped through a 1.25 cm screen on a hammer mill and ground through a 1 mm screen on a Wiley mill. Selected samples were sent to Swift Current for analysis for crude protein (CP),

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(1) Established plots and seeding equipment are set for imperial rather than metric spacings: 1 foot = 0.3048 metres.

(2) Row spacings will be one foot throughout this report unless specified otherwise.

phosphorus (P), acid detergent fibre (ADF), neutral detergent fibre (NDF), cellulose (holocellulose) (Crampton and Maynard, 1938; Matrone, 1944) organic matter (OM), and in vitro organic matter digestibility (OMD). The hemicellulose content is determined as the difference between ADF and NDF.

2. Saline gradient near Langham (established in 1981).

This trial consisted of 6 replicates and was handled in the same manner as the dry land trial. The first replicate was placed across the bottom of the gradient where the salinity and the moisture were expected to be the highest. The sixth replicate was placed near the top of the gradient where the salinity and the moisture were expected to be the lowest. The other replicates were placed between these two and were expected to be intermediate as far as salinity and moisture were concerned.

The total harvest at the maturity stage was air dried to a low moisture content, weighed, and threshed through a Hege combine. The seed was weighed so the seed and residue yields could be determined, and a sample of the residue was dried in an oven at 110°C for 4 hours to determine the moisture content. This moisture content was used to determine the dry matter (DM) yield of the residue.

Harvesting of these grasses and the handling of the samples were conducted in the same manner as described for the dry land trial.

Since salinity measurements were not taken in 1983, direct comparisons of yield and quality to salinity cannot be made. Therefore, the first four replicates (near the bottom of the gradient) were averaged and those results compared statistically by means of a two-way analysis of variance. This decision was based on the results of salinity measurements in 1982 which showed that the two highest replicates had little salinity in the upper two feet of soil and could be disregarded.

Jerusalem Artichoke

This growth trial was conducted on sandy soil at Saskatoon. The tubers planted had over-wintered in the ground in a nearby site. Immediately after being collected, these tubers were planted 35.5 cm (14 in.) apart in four replicates each containing six - 5.5 metre (18 ft.) rows, 0.9 metres (3 ft.) apart. Two rows from each replicate were harvested at full flower and two more were harvested at maturity. Both tops and tubers were collected at both stages of maturity.

The tops were dried, chopped through a 1.25 cm screen on the hammer mill and ground through a 1 mm screen on the Wiley mill after moisture samples were taken for yield determinations.

The moisture content of some of the tubers were determined for yield calculations. Some of the remaining tubers were cut into thin slices and air dried. These were ground and submitted for analysis.

Fodder Beets

Fodder beets were grown under irrigation near Outlook, Saskatchewan. W.J. King of the Irrigation Branch of Saskatchewan Agriculture obtained yield data from five cultivars; Monera, Peromona, Solanko, Petra and Peroba from D.A. Scott of Danosco Enterprises. Several tubers of Peromona were collected and their DM and sugar content determined. The DM content was determined by freeze drying.

Statistics

Means and F values were determined on an IBM-PC microcomputer by a two-way analysis of varience. Least significant differences (LSD's) were calculated from this analysis. Figures 1 to 8 each contain 3 lines marked A, B and C. A designates the mean value of the reference cultivar, Revenue. A-B and A-C show the LSD range above and below Revenue.

RESULTS AND DISCUSSION

1. Perennial Grasses

(a) Perennial grasses at anthesis, grown on dry land in Saskatoon, Saskatchewan, in 1983.

The slender wheat grass hays are not particularly high in either CP or OMD (Table 1 and Figure 1). The average CP of these grasses is 1.2% lower than that obtained from the same stand in 1982 while the average OMD is 2% higher. (Kernan et al, 1983).

It is notable that Revenue is among the lowest of the slender wheat grasses in cellulose and hemicellulose content (Table 2 and Figure 2). Altai has a high OMD and high cellulose content but a very low hemicellulose content. The SWG's have a lower cellulose content, a higher hemicellulose content but a lower OMD than Altai. This may mean that a lot of the hemicellulose in the SWG's is tied with lignin and is not available for hydrolysis without some pretreatment.

Altai, Orbit and Summit, in that order, are better producers of DM, CP and total digestible nutrient (TDN) than the SWG's (Table 3 and Figure 3). The average DM production of these grasses in 1982 was 6,485 kg/ha while in 1983 it was only 1,600 kg/ha. There are several possible reasons for this. First of all, these grasses tend to yield much better the first year after establishment (Crowle, 1984). Secondly, the soil may have deteriorated somewhat, since it is not general practice to fertilize forages. Finally, these plants sustained hail damage in June, and this may have seriously affected growth during the remainder of the year. Genotype 1269 appears to be the best of the SWG's in these respects and is considerably better than Revenue although it is low in CP and OMD from a nutritional point of view.

Table 1. Crude protein, phosphorus, organic matter and organic matter digestibility at anthesis of perennial grasses grown on dry land at Saskatoon, Saskatchewan in 1983.

Species	Cultivar (genotype)	CP(%)	P(%)	OM(%)	OMD(%)
SWG	1194	6.6	0.18	88.4	50.3
	1246	6.5	0.17	88.6	50.9
	1269	6.6	0.16	89.4	48.4
	1307	6.1	0.17	89.1	46.1
	1320	6.6	0.18	88.7	47.8
	1346	6.2	0.16	88.7	48.9
	1358	6.4	0.17	88.3	49.1
	1385	6.9	0.18	88.2	49.0
	1587	6.5	0.17	89.0	47.4
	1650	7.1	0.19	87.3	48.2
	1711	6.7	0.16	88.5	50.0
	1717	6.9	0.18	88.1	51.2
	Revenue	7.4	0.17	88.2	50.8
TWG	Orbit	6.7	0.18	88.2	52.2
CWG	Summit	6.3	0.15	91.5	53.6
WRG	Altai	8.7	0.18	89.6	54.2
Sig. of Cultivar Effect		**	**	**	**
Least Sig. Diff. (p=0.05)		0.7	0.02	1.4	2.1

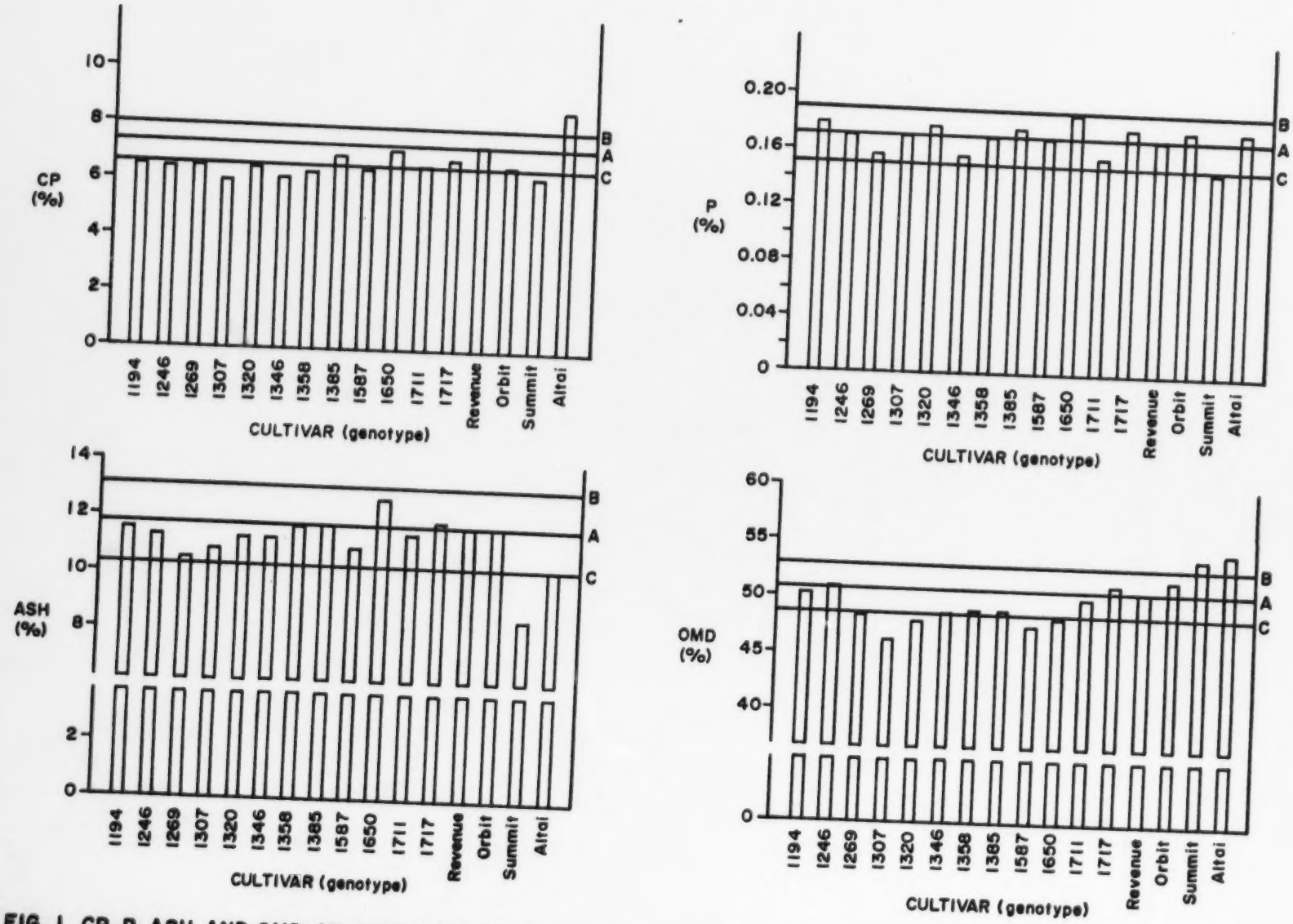

FIG. 1 CP, P, ASH AND OMD AT ANTHESIS OF PERENNIAL GRASSES GROWN ON DRY LAND AT LANGHAM, SASK. IN 1983.

Table 2. Fibre content at anthesis of perennial grasses grown on dry land at Saskatoon, Saskatchewan in 1983

Species	Cultivar (genotype)	ADF (%)	NDF (%)	Cellulose (%)	Hemicellulose (%)
SWG	1194	37.6	68.2	36.0	30.6
	1246	36.9	68.4	39.9	31.5
	1269	38.2	69.8	39.1	31.5
	1307	37.6	68.6	36.8	31.1
	1320	37.3	67.0	38.4	29.7
	1346	37.7	68.2	40.6	30.5
	1358	37.2	68.2	40.9	31.0
	1385	35.4	66.6	35.4	31.2
	1578	37.2	69.4	39.7	32.2
	1650	36.7	68.3	36.3	31.6
	1711	38.1	69.6	42.3	31.6
	1717	37.1	66.7	39.4	29.6
	Revenue	38.8	68.7	34.2	29.9
TWG	Orbit	42.4	71.3	42.7	28.9
CWG	Summit	36.7	64.3	35.2	27.7
WRG	Altai	42.9	70.0	43.6	27.1
Sig. of Cultivar Effect		**	**	**	**
Least Sig. Diff. (p=0.05)		2.1	2.2	1.3	1.3

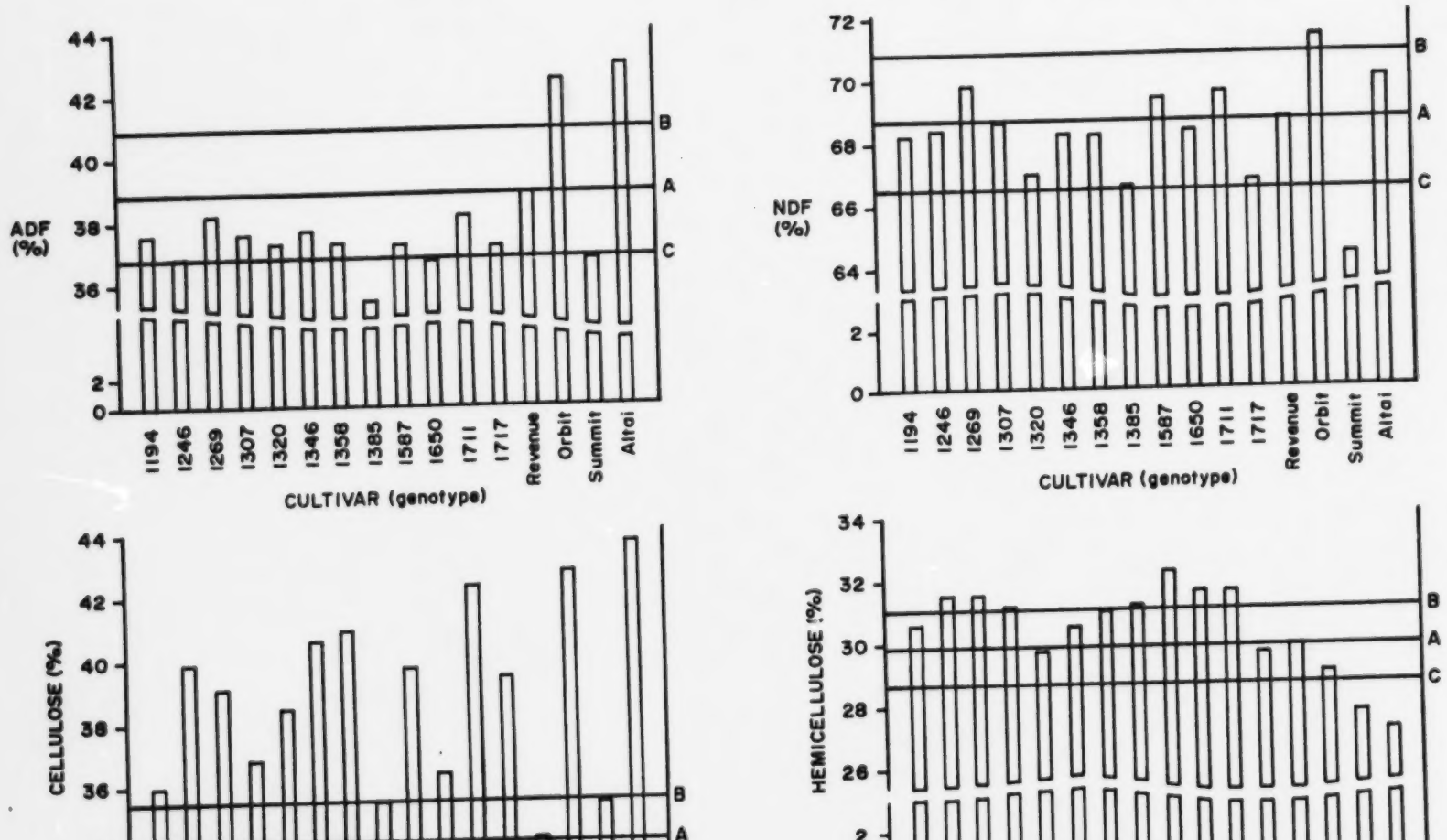

FIG. 2 FIBRE CONTENT AT ANTHESIS OF PERENNIAL GRASSES GROWN ON DRY LAND AT SASKATOON, SASK. IN 1983.

Table 3. Dry matter yield and production of crude protein and digestible organic matter at anthesis by perennial grasses grown on dry land at Saskatoon, Saskatchewan in 1983

Species	Cultivar (genotype)	Production (kg/ha)		
		DM	CP	TDN
SWG	1194	1191	78	533
	1246	1276	82	583
	1269	1964	122	855
	1307	1657	102	687
	1320	1824	120	771
	1346	1741	106	760
	1358	1264	80	555
	1385	849	58	368
	1587	1547	97	660
	1650	936	66	400
	1711	1091	71	485
	1717	1512	101	689
	Revenue	1298	95	590
TWG	Orbit	2148	146	995
CWG	Summit	1845	115	913
WRG	Altai	3432	296	1686
Sig. of Cultivar Effect		**	**	**
Least Sig. Diff. (p=0.05)		828	49	358

FIG. 3 PRODUCTION OF DM, CP AND TDN AT ANTHESIS BY PERENNIAL GRASSES GROWN ON DRY LAND AT SASKATOON, SASK. IN 1983.

(b) Perennial grasses at anthesis grown on a saline gradient near Langham, Saskatchewan, in 1983.

Altai has the highest CP content and OMD of all these grasses (Table 4 and Figure 4). None of the SWG genotypes are significantly better than Revenue in CP content and OMD. Genotype 1711 is best and 1269 the poorest in these respects.

Genotype 1269 did not have high cellulose and hemicellulose contents in this trial (Table 5 and Figure 5) as it did in the dry land trial (Table 2 and Figure 2). Genotype 1320 was the only grass significantly higher than Revenue in both cellulose and hemicellulose content.

The saline conditions affect Summit and especially Altai in DM, CP and TDN production (Table 6 and Figure 6). Orbit produces better than Revenue but not significantly so. SWG genotypes 1269, 1320 and 1650 were significantly higher than Revenue in DM production and only genotype 1269 was significantly higher than Revenue in TDN production. Genotype 1269 was the highest, but none of the grasses were significantly different from Revenue in CP production. DM, CP and TDN production were higher for the SWG's on the saline site at Langham than on the dry land site at Saskatoon, probably due to hail damage sustained in June.

Table 4. Crude protein, phosphorus, organic matter and organic matter digestibility at anthesis of perennial grasses grown on a saline gradient near Langham

Species	Cultivar (genotype)	CP(%)	P(%)	OM(%)	OMD(%)
SWG	1194	6.0	0.14	93.0	46.2
	1246	5.8	0.16	92.4	47.5
	1269	5.3	0.14	92.6	44.6
	1307	5.2	0.16	92.6	45.6
	1320	4.9	0.15	92.7	45.7
	1346	6.1	0.15	92.7	47.2
	1358	6.0	0.15	93.4	46.2
	1385	5.7	0.15	92.8	46.6
	1587	5.6	0.15	92.3	45.3
	1650	5.3	0.15	91.7	45.3
	1711	6.3	0.16	90.3	49.1
	1717	5.8	0.15	92.4	47.7
	Revenue	6.1	0.16	92.8	48.7
TWG	Orbit	6.3	0.17	90.8	49.7
CWG	Summit	5.9	0.16	90.9	50.9
WRG	Altai	8.1	0.19	89.0	56.1
Sig. of Cultivar Effects		**	**	*	**
Least Sig. Diff. (p=0.05)		0.9	0.019	2.4	4.3

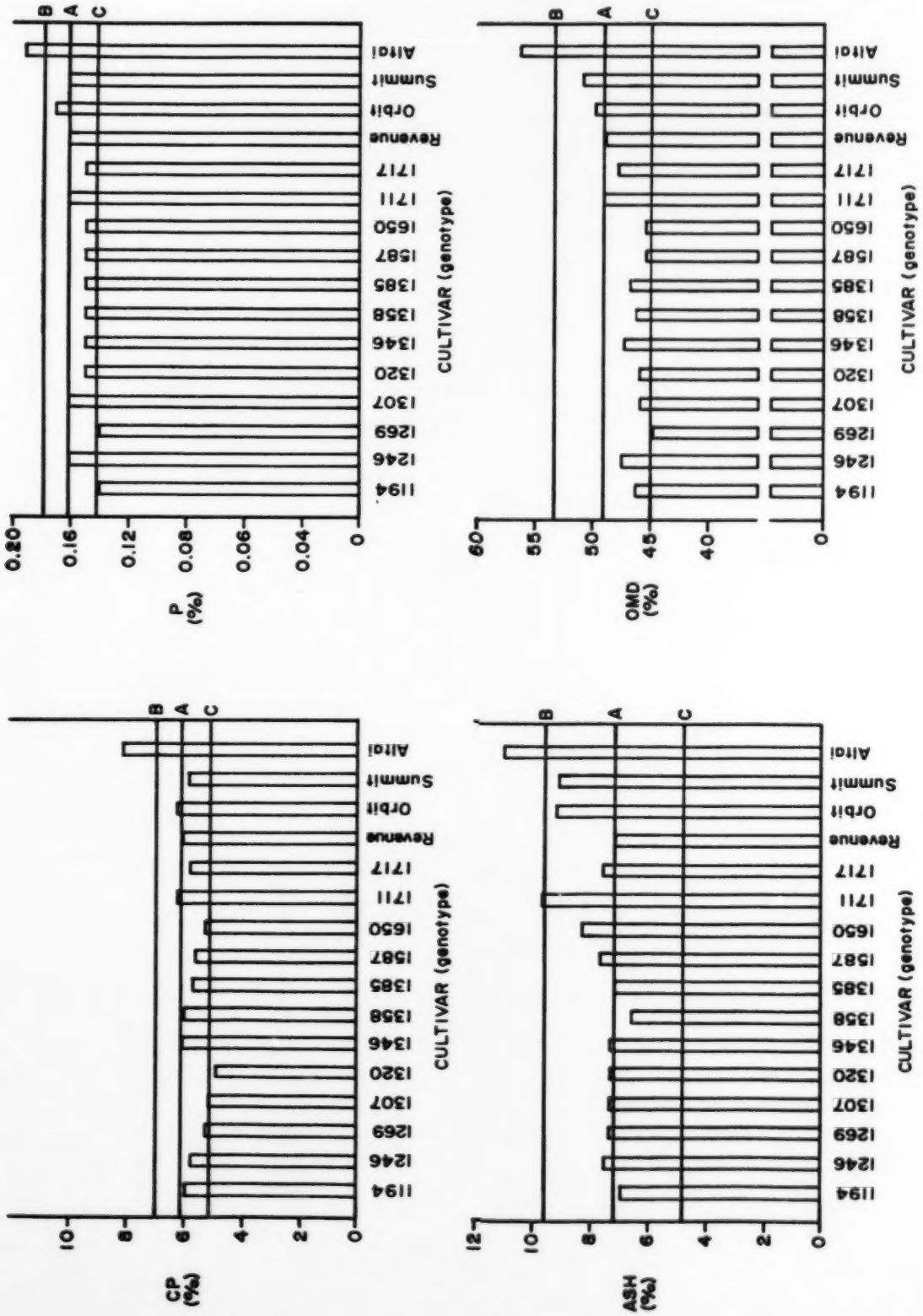

FIG. 4 CP, P, ASH AND OMD AT ANTHESIS OF PERENNIAL GRASSES GROWN ON A SALINE GRADIENT NEAR LANGHAM, SASK. IN 1983.

Table 5. Fibre content at anthesis of perennial grasses grown on a saline gradient near Langham, Saskatchewan in 1983.

Species	Cultivar (genotype)	ADF (%)	NDF (%)	Cellulose (%)	Hemicellulose (%)
SWG	1194	41.3	74.2	38.9	32.9
	1246	41.4	74.7	37.7	33.2
	1269	42.3	74.7	41.5	32.3
	1307	42.0	75.6	44.8	33.6
	1320	42.7	76.9	44.4	34.2
	1346	41.5	76.0	40.4	34.6
	1358	41.7	75.5	39.6	34.0
	1385	41.6	75.2	42.8	33.7
	1587	41.8	75.9	43.2	34.1
	1650	42.6	75.0	45.2	32.4
	1711	39.8	72.6	38.9	32.8
	1717	41.6	74.0	39.7	32.4
	Revenue	42.2	74.5	40.4	32.4
TWG	Orbit	42.8	74.2	42.9	31.4
CWG	Summit	40.1	69.2	40.0	29.1
WRG	Altai	42.0	72.2	44.5	30.2
Sig. of Cultivar Effect		NS	**	**	**
Least Sig. Diff. (p=0.05)		2.7	2.9	3.4	1.6

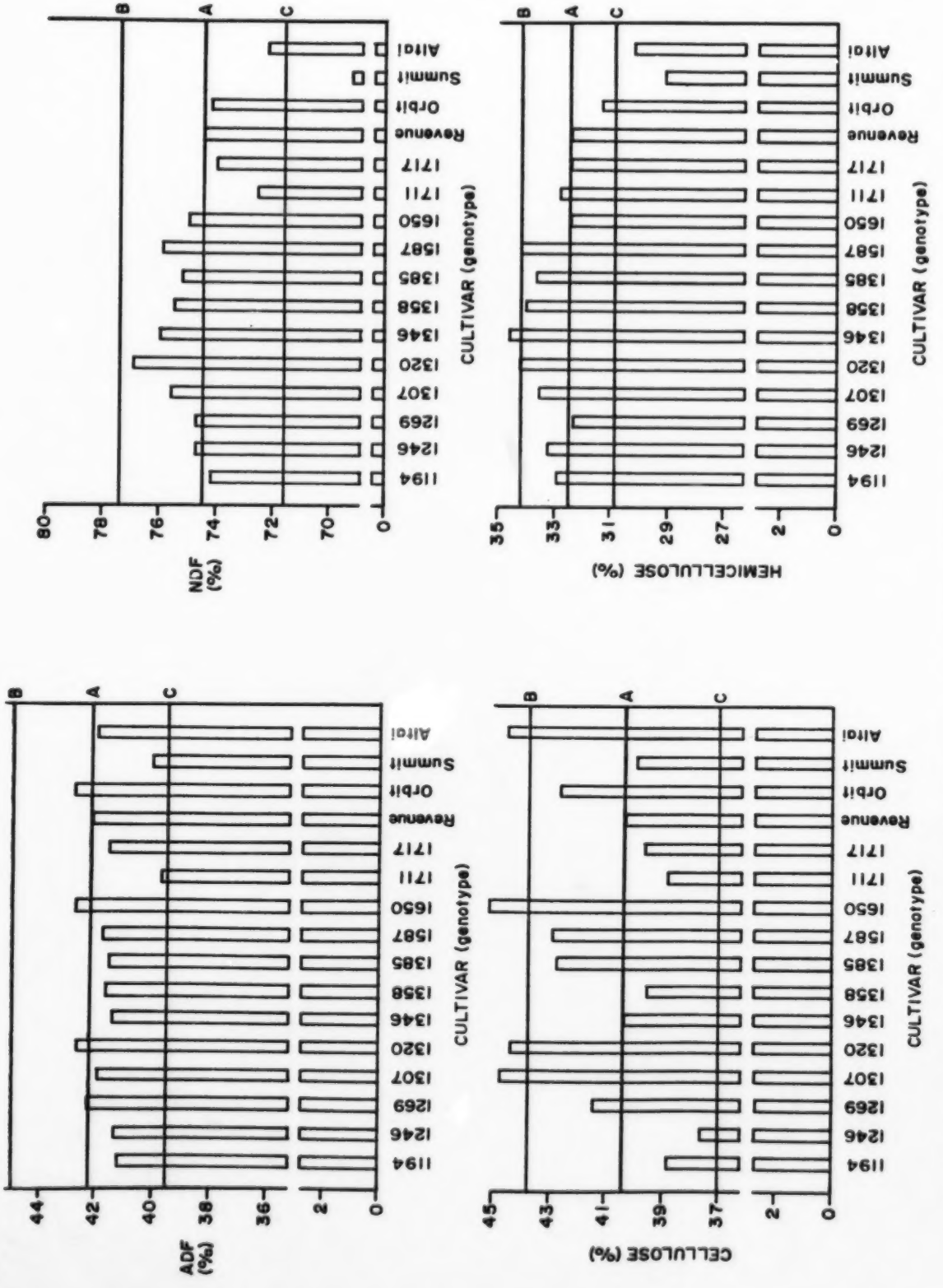

FIG. 5 FIBRE CONTENT AT ANTHESIS OF PERENNIAL GRASSES GROWN ON A SALINE GRADIENT NEAR LANGHAM, SASK. IN 1983.

Table 6. Dry matter yield and production of crude protein and total digestible nutrients at anthesis for perennial grasses grown on a saline gradient near Langham, Saskatchewan in 1983.

Species	Cultivar (genotype)	Production (kg/ha)		
		DM	CP	TDN
SWG	1194	1773	137	989
	1246	2579	158	1140
	1269	3041	162	1272
	1307	2632	137	1124
	1320	2865	140	1233
	1346	2187	128	952
	1358	1743	104	760
	1385	1598	86	687
	1587	2331	132	992
	1650	2727	145	1146
	1711	1818	103	786
	1717	1928	107	847
	Revenue	1719	101	775
TWG	Orbit	2186	139	975
CWG	Summit	1362	80	634
WRG	Altai	483	36	246
Sig. of Cultivar Effect		*	N	*
Least Sig. Diff. (p=0.05)		1203	69	479

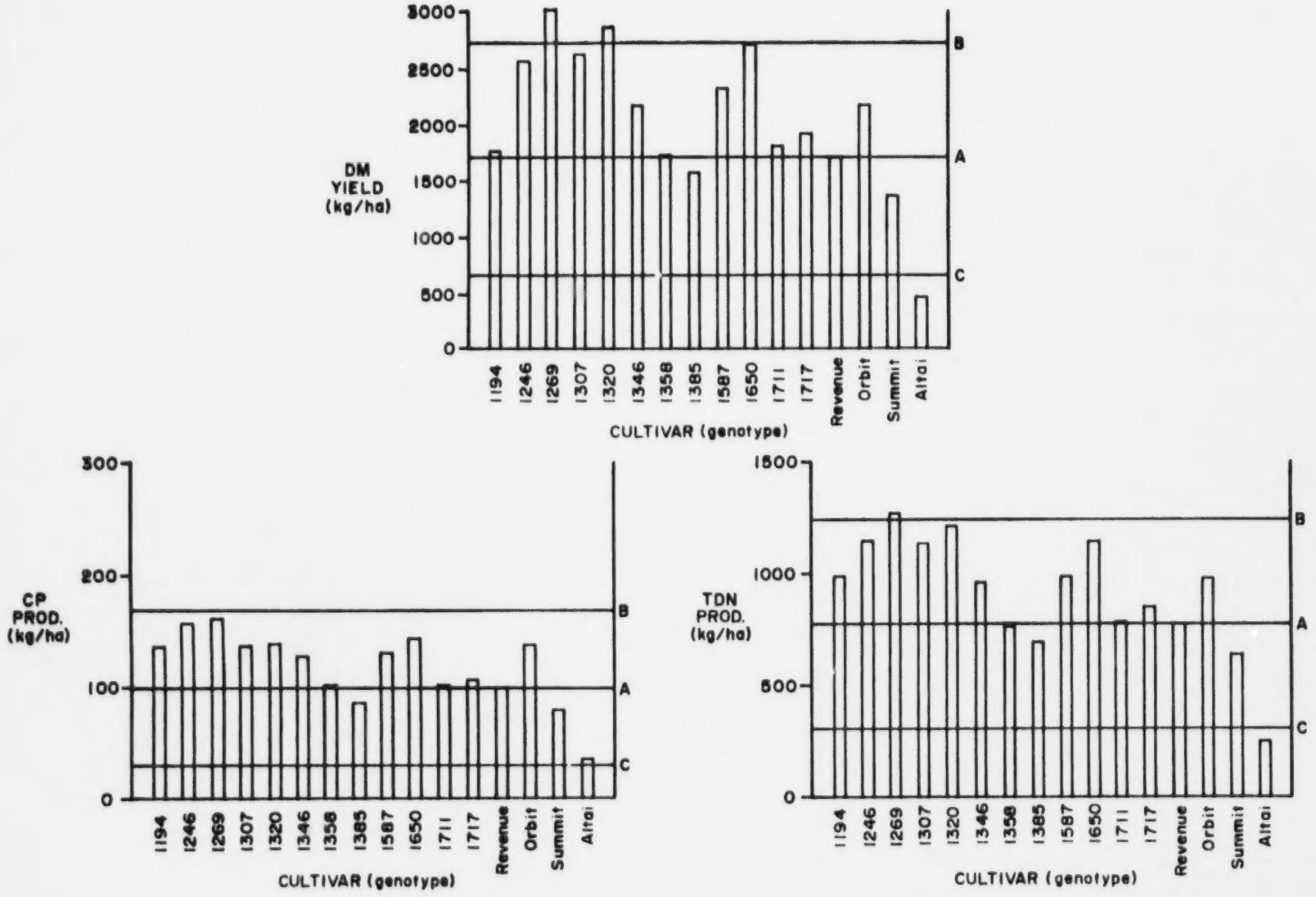

FIG. 6 PRODUCTIVITY OF DM, CP AND TDN AT ANTHESIS BY PERENNIAL GRASSES GROWN ON A SALINE GRADIENT NEAR LANGHAM, SASK. IN 1983.

(c) Perennial grass residues at maturity, grown on the saline gradient near Langham, Saskatchewan in 1983.

Surprisingly, Altai has by far the highest CP and OMD content of all the grasses at this stage of maturity (Table 7 and Figure 7). This indicates that the forage quality of Altai does not deteriorate as rapidly as for the other perennial grasses as maturity proceeds. None of the other grasses are significantly different from Revenue in CP content and only Summit is significantly higher in OMD.

Orbit is the lowest of all the grasses in DM, CP and TDN production (Table 8 and Figure 8) and is the only one significantly lower than Revenue. Altai is higher than Revenue in CP production but is lower in TDN production. SWG genotypes 1269, 1307, 1587 and 1650 are higher than Revenue in both CP and TDN production, but not significantly so.

These results indicate that SWG genotype 1269 shows up quite well in these trials in DM, CP and TDN production which may be important as far as energy is concerned. However more testing would be required to confirm this tentative conclusion. Based on the results of these three trials it is not possible to choose a genotype which is consistantly better than Revenue in CP content.

Table 7. Composition at maturity of perennial grass residues grown on a saline gradient at Langham, Saskatchewan in 1983.

Species	Cultivar (genotype)	CP (%)	P (%)	OM (%)	OMD (%)
SWG	1194	3.1	0.07	94.5	44.9
	1246	3.0	0.09	93.9	42.9
	1269	2.8	0.08	93.9	42.9
	1307	2.8	0.10	93.7	42.7
	1320	2.8	0.10	93.8	44.3
	1346	2.8	0.10	93.8	43.8
	1358	3.0	0.09	94.9	44.4
	1385	3.0	0.09	94.3	43.4
	1587	2.9	0.09	93.5	42.2
	1650	2.8	0.10	93.5	41.9
	1711	3.0	0.08	93.4	42.3
	1717	3.3	0.09	93.7	45.1
	Revenue	3.3	0.09	93.8	42.8
TWG	Orbit	3.5	0.09	92.8	45.4
CWG	Summit	3.1	0.11	94.1	47.0
WRG	Altai	6.6	0.12	91.2	51.1
Sig. of Cultivar Effect		**	*	**	**
Least Sig. Diff. (p=0.05)		0.8	0.04	1.0	2.6

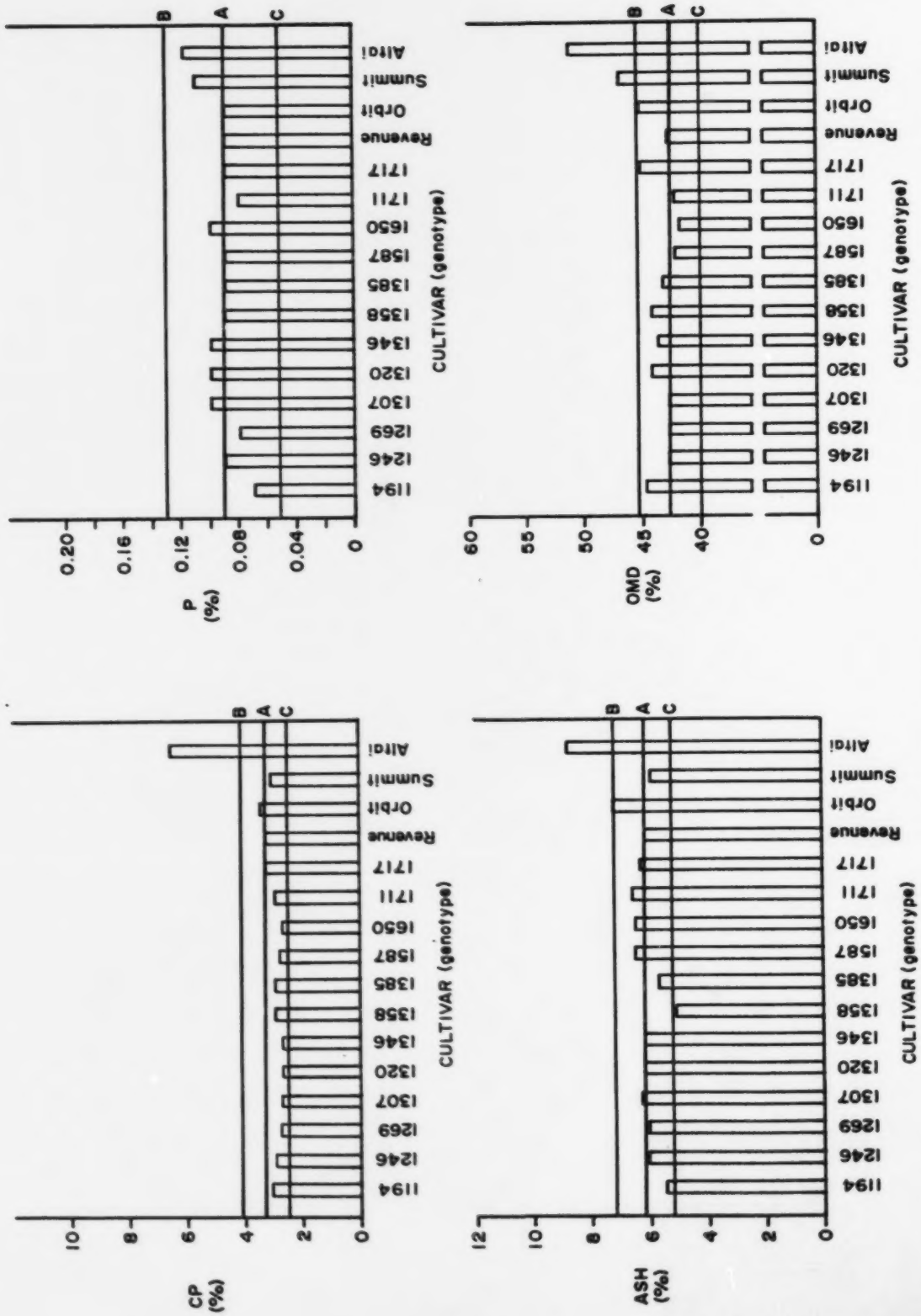

FIG. 7 CP, P, ASH AND OMD AT MATURITY OF PERENNIAL GRASS RESIDUE GROWN ON A SALINE GRADIENT NEAR LANGHAM, SASK. IN 1983.

Table 8. Dry matter yield and production of crude protein and total digestible nutrients at maturity of perennial grass residues grown on a saline gradient near Langham, Saskatchewan in 1983.

Species	Cultivar (genotype)	Production (kg/ha)		
		DM	CP	TDN
SWG	1194	1769	52	750
	1246	2280	63	921
	1269	2556	74	1045
	1307	2661	74	1078
	1320	2018	58	852
	1346	1958	54	815
	1358	1973	57	838
	1385	2205	61	898
	1587	2437	71	973
	1650	2766	78	1098
	1711	1845	55	740
	1717	2138	64	905
	Revenue	2033	64	820
TWG	Orbit	855	26	378
SWG	Summit	2063	64	925
WRG	Altai	1323	90	615
Sig. of Cultivar Effect		NS	NS	NS
Least Sig. Diff. (p=0.05)		1143	35	477

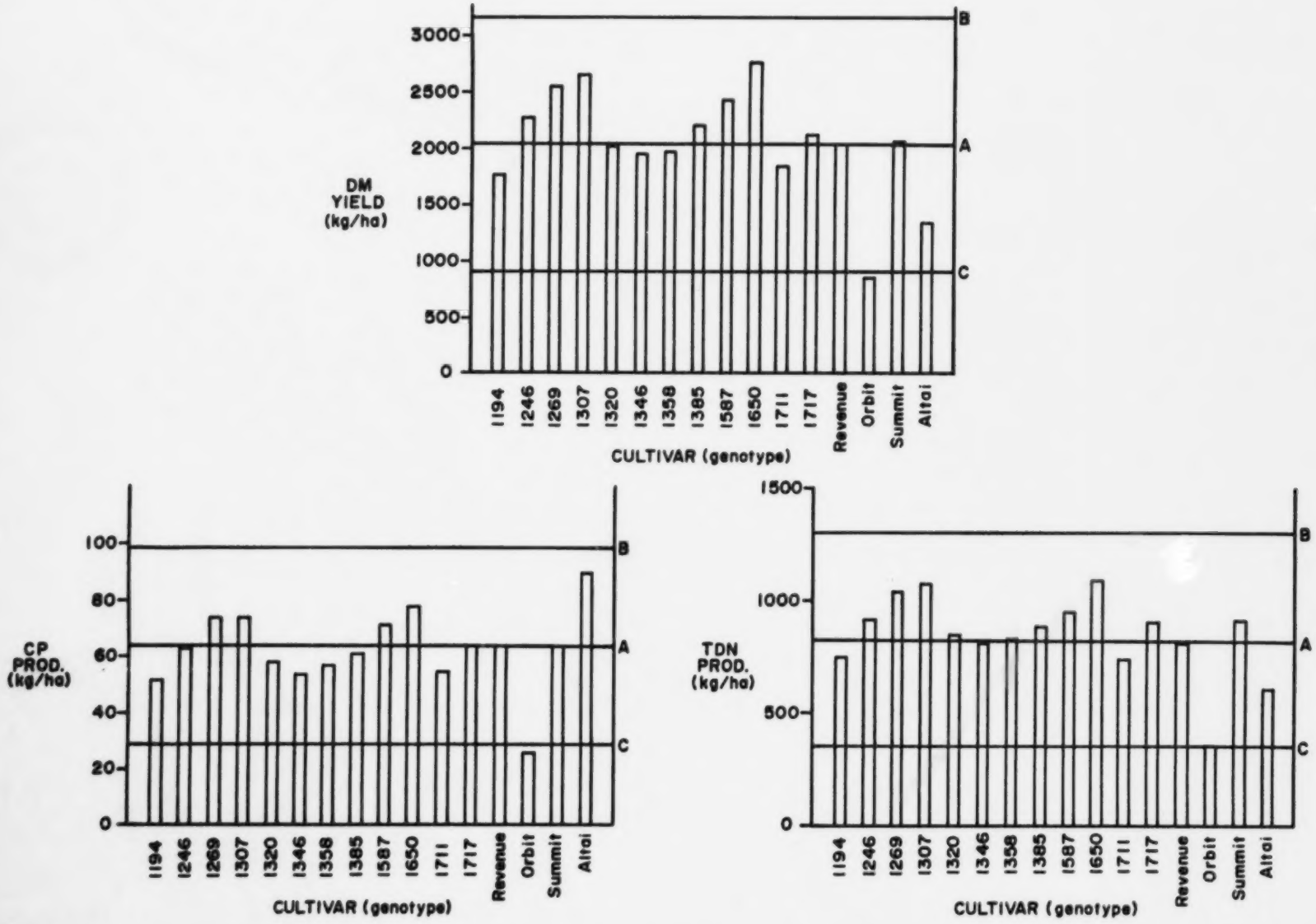

FIG. 8 PRODUCTION OF DM, CP AND TDN AT MATURITY OF PERENNIAL GRASS RESIDUES GROWN ON A SALINE GRADIENT NEAR LANGHAM, SASK. IN 1983.

2. Jerusalem Artichoke

Jerusalem artichoke tops show a significant decrease in CP, P and OMD with maturity while the tubers are relatively stable (Table 9 and Figure 9). The tops show a highly significant decrease in DM, CP and TDN production with maturity while the tubers show a highly significant increase. (Table 10 and Figure 9). The total production (combined tops and tubers) of CP and TDN at the full flowering (FF) stage of maturity is considerably higher than at the mature (M) stage, but not significantly so (Table 11).

It appears as though a higher yield of hydrolyzable material can be produced at full flowering than at the mature stage. This could be useful if an economical and effective pretreatment for the tops can be developed and if extractable protein would become a useful by-product. However, for this to become practical, a harvesting system which would collect both the tops and tubers in a single pass would be necessary.

As a feedstuff for ruminants the tops have a reasonably good energy digestibility, even at the mature stage. Since the protein content is low and the forage does not respond well to ammonia treatment (Kernan et al, 1981) a protein supplement would have to be added to the Jerusalem artichoke tops, especially those harvested at the mature stage. Under the present harvesting system the crop would be best harvested at the mature stage for the tubers only, leaving the tops on the land.

Table 9. Composition of Jerusalem artichoke tops and tubers at two stages of maturity, grown on dry land at Saskatoon, Saskatchewan in 1983.

Stage of Maturity	Tops(%)				Tubers(%)			
	CP	P	OM	OMD	CP	P	OM	OMD
Full Flower	6.9	0.15	90.9	69.6	5.5	0.25	93.2	91.5
Mature	2.9	0.08	94.2	55.9	6.8	0.24	95.1	91.8
SME(1)	*	*	*	* *	NS	NS	NS	NS
LSD(2)(p=0.05)	3.05	0.047	2.10	1.91	2.74	0.021	4.45	0.50

Table 10. Height and production of DM, CP and TDN for Jerusalem artichoke tops and tubers at two stages of maturity grown on dry land at Saskatoon, Saskatchewan in 1983.

Stage of Maturity	Height (cm)	TOPS Production (kg/ha)			TUBERS Production (kg/ha)		
		DM	CP	TDN	DM	CP	TDN
Full Flower	123	5600	385	3590	1547	86	1335
Mature	128	2424	69	1297	3344	226	2964
SME(1)	**	**	**	**	**	**	**
LSD(2)(p=0.05)	-(3)	759	160	431	484	70	414

(1)Significance of maturity effect.

(2)Least significant difference.

(3)The within treatment variation was extremely small causing the F value to be infinitely large. The LSD could not be calculated.

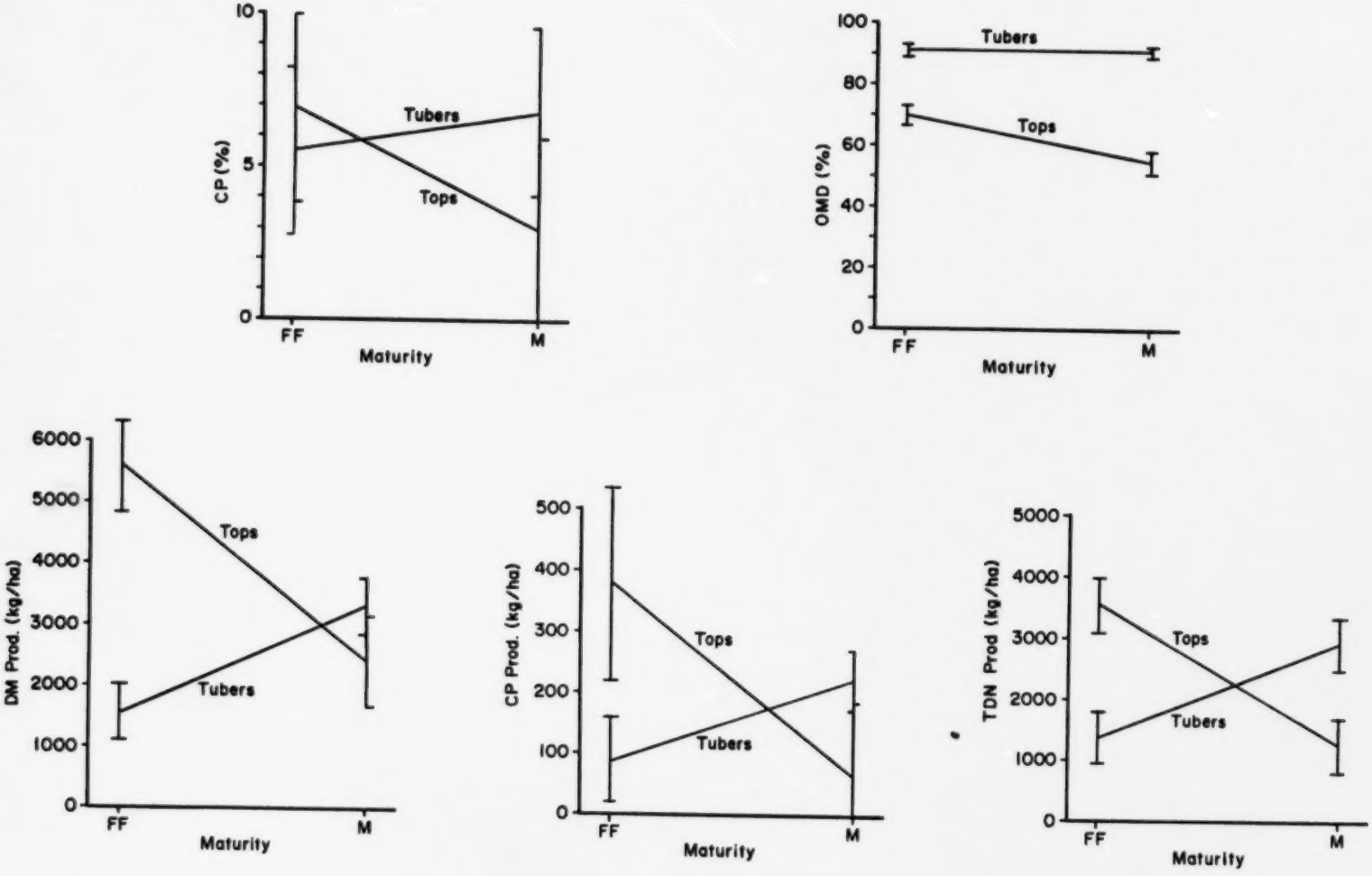

Fig. 9 Effect of maturity on the CP and OMD content and the DM, CP and TDN production of Jerusalem artichoke tops and tubers grown on dry land at Saskatoon, Saskatchewan in 1983.

Table 11. Production of DM, CP and TDN for tops plus tubers from Jerusalem artichokes grown on dry land at Saskatoon, Saskatchewan in 1983.

Stage of Maturity	Production (kg/ha)		
	DM	CP	TDN
Full Flower	7222	471	4925
Mature	5768	295	4260
SME	*	NS	NS
LSD (p=0.05)	1211	200	823

Compared to the results obtained in 1982 (Kernan et al, 1983) Jerusalem artichoke is not outstanding as a dryland crop unless both tops and tubers are considered. However, this comparison is not truly valid since the rainfall was more equitably distributed in 1982 than in 1983 (Table 13) and the productivity of other, non-irrigated crops may be lower in 1983.

3. Fodder Beets

Based on an irrigated growing trial conducted by Scott (1984) near Outlook in 1983, the fodder beet cultivar, Peromona, had the highest yield of fresh weight tubers (Table 12). Some Peromona tubers were collected, and a weighed sample was thinly sliced and freeze dried. The moisture content of the tubers was 80.1% and the DM yield of Peromona tubers was 30.6 tonnes/ha. This yield is at the top of the range reported by Earl and Brown (1979) for the crop grown in New Zealand.

The sucrose equivalent in Peromona was 15.0% on a fresh weight basis or 75.4% of DM determined by the phenol-sulfuric acid analysis for total

Table 12. Fresh yields of fodder beets grown under irrigation at Outlook, Saskatchewan in 1983.

Cultivar	Yield (tonnes/ha)		
	Tops	Tubers	Total
Monera	80.5	141.2	221.7
Peromona	51.8	153.6	205.4
Solanka	40.1	97.8	137.9
Petra	51.8	125.8	177.6
Peroba	64.1	104.3	168.4

soluble carbohydrate. This is in agreement with Henderson et al (1982) who reported that sucrose equivalent concentrations of four cultivars varied from 9.4% to 18.9% on a fresh weight basis. Thus the production of soluble sugar expressed as a sucrose equivalent would be 23.1 tonnes/ha. This is a higher yield than that reported for the Canadian production of sugar beets by Fleming and GrootWassink (1979) who gave a range of from 9.8 to 13.2 tonnes of sugar/ha.

The concentration of sugar in fresh fodder beet tubers is in the range reported for sugar beets (10-22%) by Kirk-Othmer (1983). For the last two years the sucrose content for sugar beets in Alberta was approximately 16% (Bergen, 1984). Since in western Canada sugar beets are stored frozen in piles near the highway awaiting processing; the same could apply to fodder beets grown for ethanol purposes. Therefore, if the

1983 results were anywhere near accurate, fodder beets might be an excellent energy crop for the Outlook area. If an ethanol plant was to be constructed to utilize the sugar from fodder beets, a feedlot to consume the fodder beet residue may also be worth considering.

4. Saskatoon Climatic Conditions in 1982 and 1983.

The frost free season at Saskatoon was 111 days in 1983 lasting from May 24 to September 13 compared to 89 days in 1982 lasting from May 29 to August 27 (Table 13). A severe thunderstorm accompanied by a very intense rainfall (94.6 mm in 45 minutes) hit the City of Saskatoon at 5:30 p.m. Friday, June 24th. Considerable crop damage was sustained at the Canada Agriculture experimental plots near the Forestry Farm. (Wheaton et al, 1984).

Table 13. Climate factors for Saskatoon for the growing seasons of 1982 and 1983, compared to long-term averages (LTA-1951-1980)

Period 1982 1983	Mean Temperature (°C)			Growing Degree days (DGG)			Precipitation (mm)			Sunshine (hrs)		
	1982	1983	LTA	1982	1983	LTA	1982	1983	LTA	1982	1983	LTA
April	2.0	3.0	3.4	54	52	47	14.1	41.7	21.4	253	253	232
May	9.5	8.5	11.2	170	145	199	75.6	53.4	39.6	205	282	292
June	15.2	15.5	15.6	304	319	319	50.8	117.2	59.9	332	279	294
July	17.5	19.0	18.4	397	433	416	79.8	68.6	56.2	317	315	341
August	16.0	20.0	17.2	338	469	379	77.8	30.0	35.1	301	340	293
Sept.	11.0	10.0	11.5	198	169	201	42.0	62.2	32.2	188	178	191
Oct.	5.5	5.3	5.2	60	44	71	12.2	6.4	17.5	182	178	175

From Wheaton et al. 1984.

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